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An I2C and Ethernet based open-source solution for home automation in the IoT context

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- ✓ Proposed solution
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Introduction

➢ Concepts:

- ❖ **Home or building automation** – may include any physical process that occurs mostly indoors and it can be human - assisted (ex. temperature, humidity, light control);

- ❖ **Remote assistance** – consists in a set of actions and commands, generated by the human factor, that is not physically present at the scene of the process but he is virtually the main part of the process.

Context

➢ Modern means of process assistance:

- **Application specific microcontroller** – is one of the best choice when a standalone - modular design is needed for a specific part of the process assistance (interfacing) or, the whole process assistance (ex. ATtiny 45, PIC, dsPIC);

- **Software re-configuration** – extends the limits of a functional - fixed application (ex. using a software interface for changing the light color in LED based lighting system)

- **Communication bus** – can raise the functional level of a simple microcontroller application (ex. automotive CAN or the simple inter – integrated circuit communication in a household appliance - I^2C);

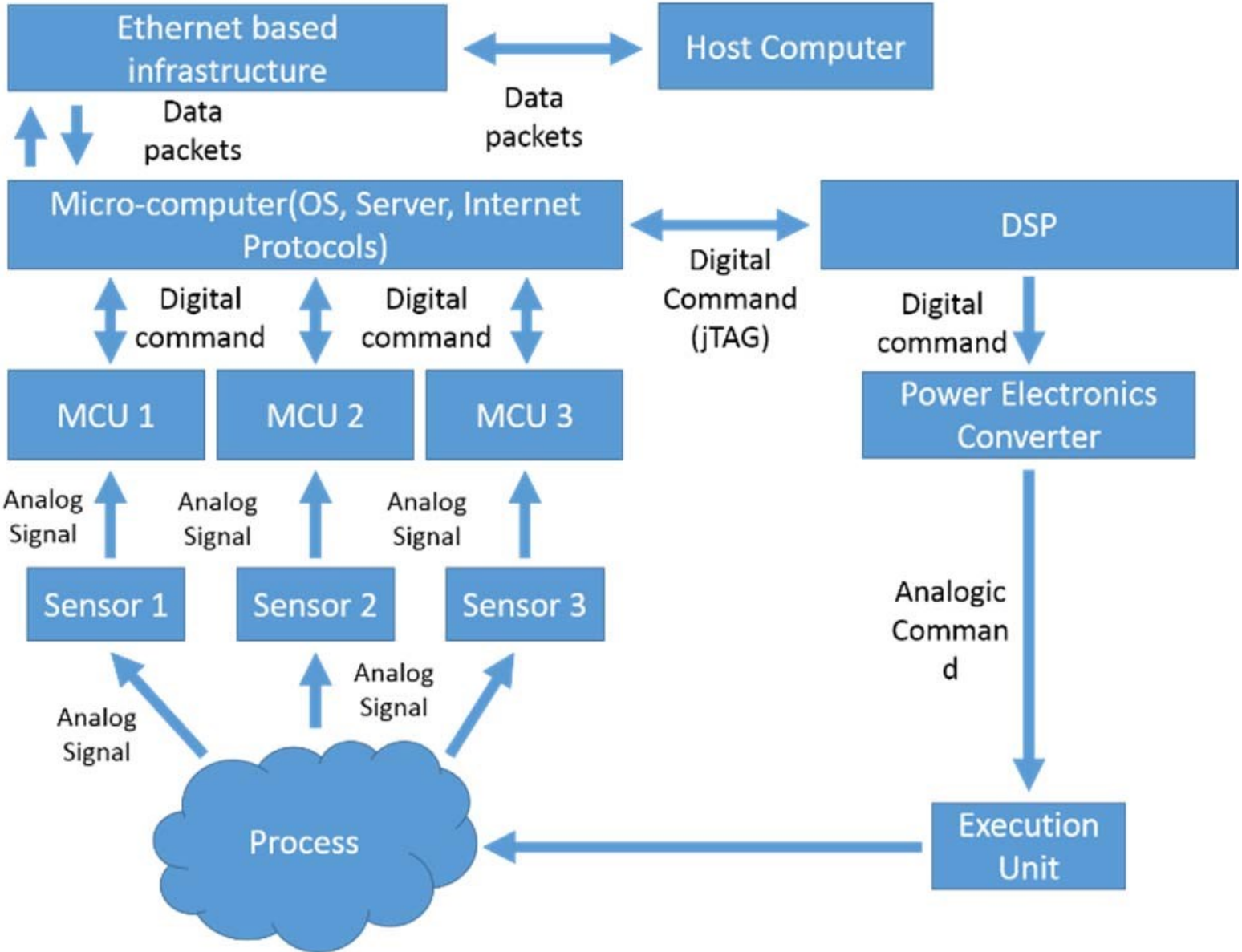
- **Internet or local network access** – makes remote assistance possible mostly in any place (ex. the IoT);

Proposed solution

- **Hardware solution:**

In order to satisfy the actual context imposed by Internet of Things standards, nowadays, most of the solutions for home automation consists of a hierarchical structure based on microcontroller network (shared bus), and a main gateway device (as described in the next slide):

Introduction



Proposed solution

➢ Hardware solution:

A common solution for large microcontroller - based networks is the I^2C communication protocol.

- **I^2C** – is a standard communication protocol between two microcontrollers, or microcontroller - based sensors. It uses the universal synchronous receiver transmitter module built in the microcontroller, and, it requires two wires only. All devices that exchange data in I^2C mode, are using an unique address, and share the same two wires bus. Maximum length of the wires is almost 2 [m]. Differential distance extenders can reach up to 30 [m].

Proposed solution

➢ Hardware solution:

- **AVR ATTiny 45** – is a robust, low power, integrated circuit micro – controller, that can be easily programmed by Open Source Arduino IDE. It is used to build custom I^2C modules (slaves) that share the same bus with a microcomputer master device.

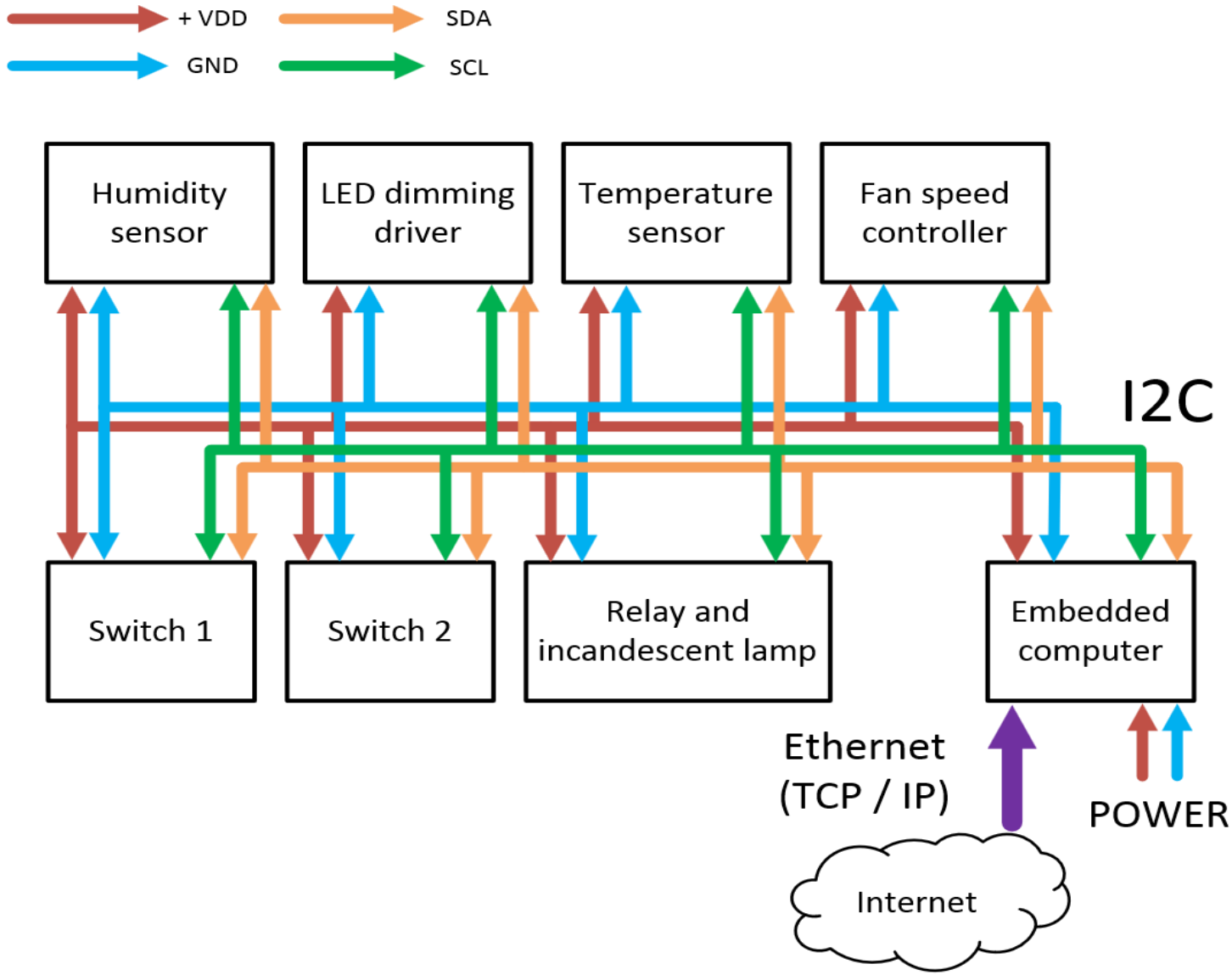
Proposed solution

➢ Hardware solution:

- **Intel Galileo** – is an embedded computer, that can run an operating system (mostly Linux). It also has I^2C capabilities, and ethernet access. This means, that this device, can be easily converted to an I^2C to Ethernet gateway.

Combining all the proposes solution together, a hierarchical I^2C network can be built, and it can be considered part of the electrical grid at home.

Proof of concept – I²C network



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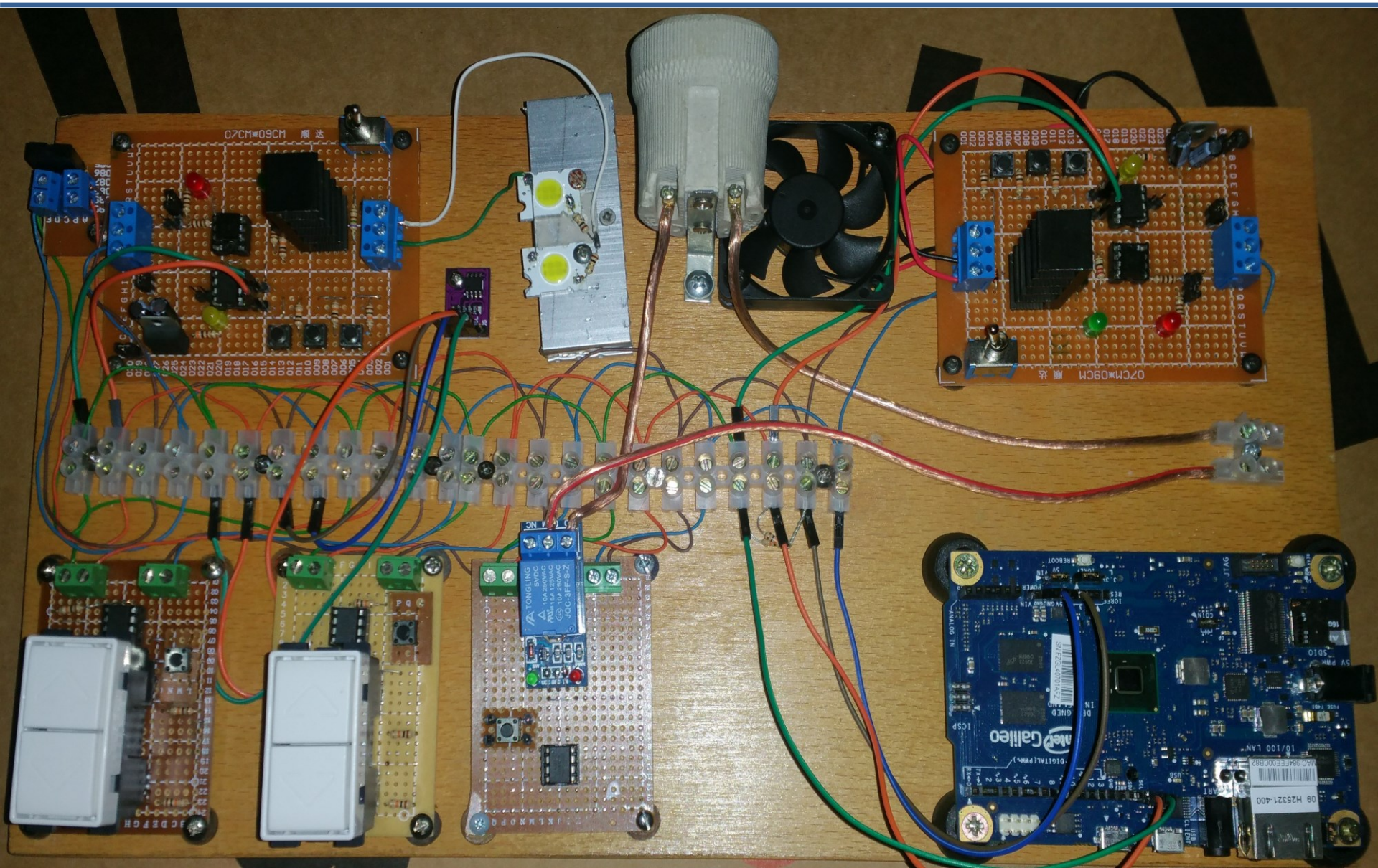
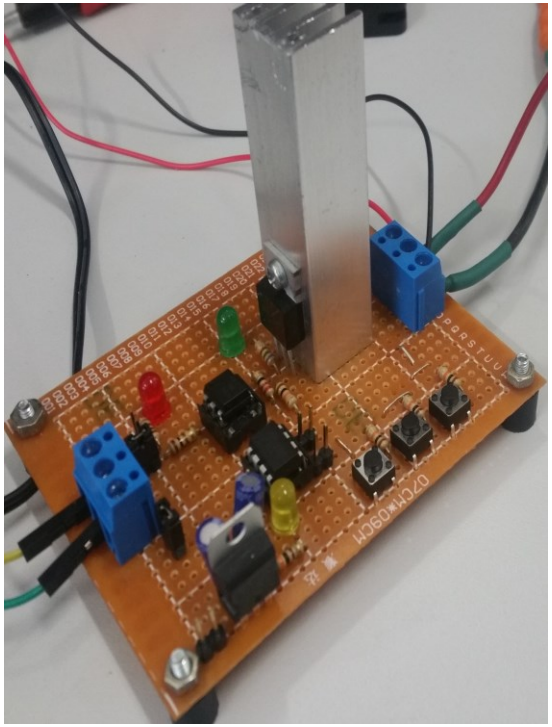
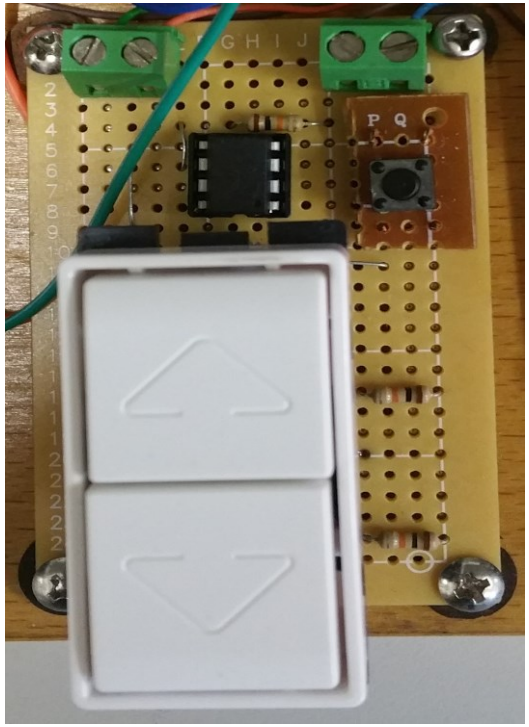
Proof of concept – hardware test platform



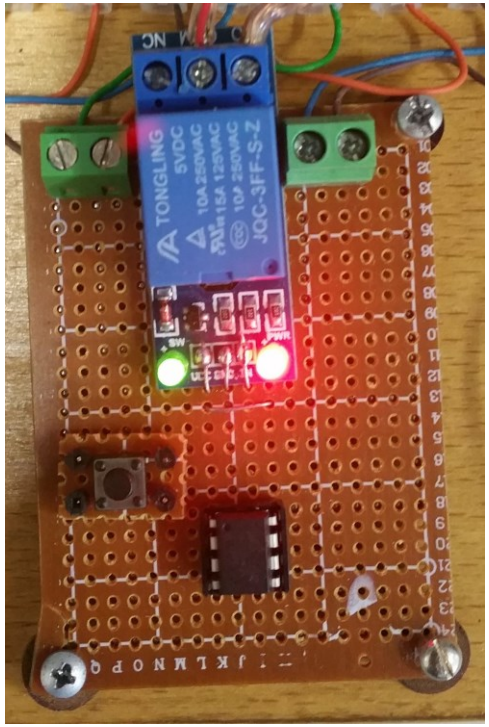
Proof of concept - Modules



Power electronics converter
(dc – dc chopper)
I²C capable



Digital switch
(Dimmer, ON / OFF)
I²C capable



Digital relay
I²C capable

Proof of concept

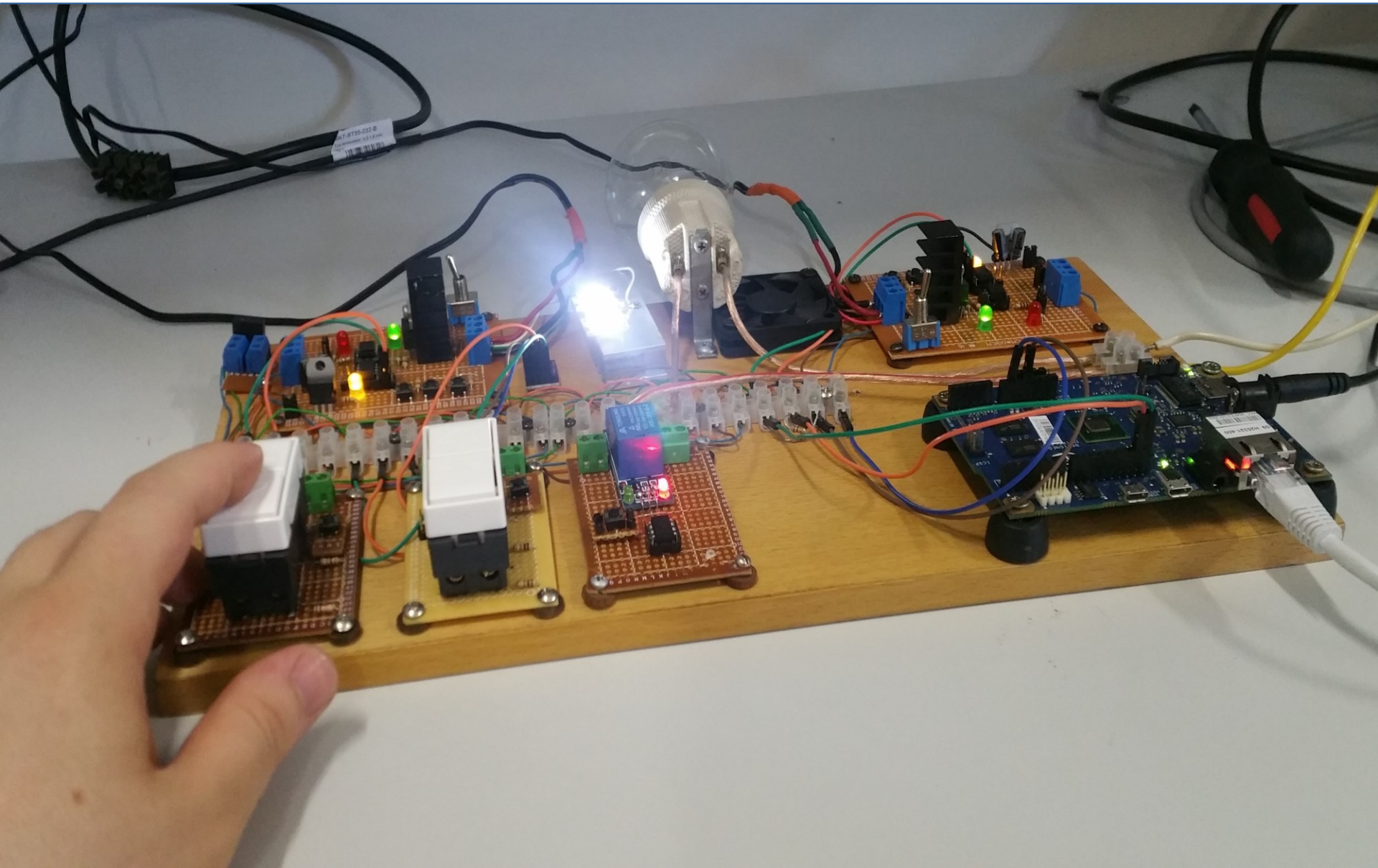
➢ Software solutions:

- **Singular Python application** – is a good choice when it comes to “silent” standalone operation of the smart grid, so, that the human interaction with the system is done only by hardware means (ex. LCD, encoder, buttons). Remote maintenance can be done using SSH.

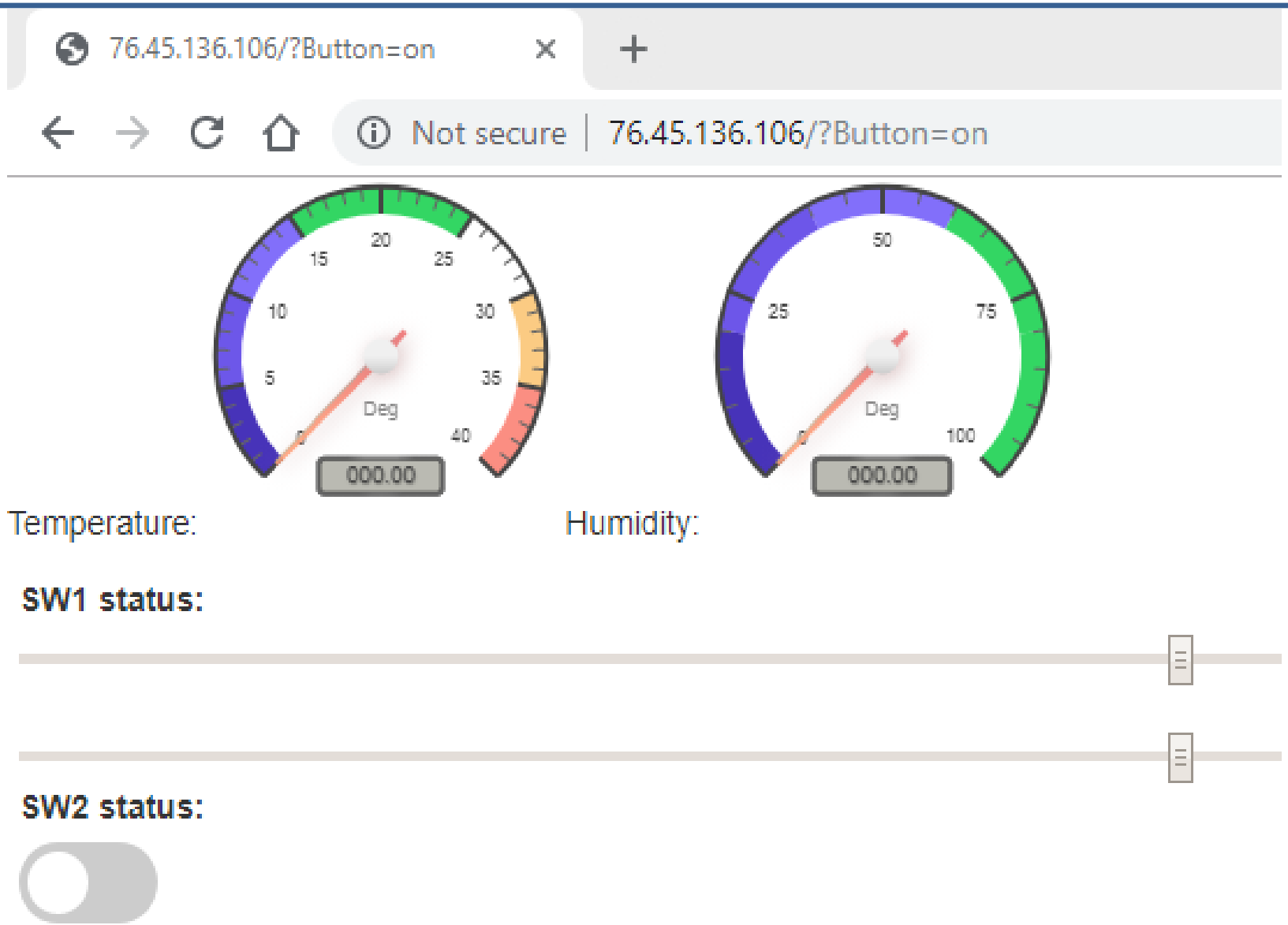
- **Webserver - Python application** – gives freedom to custom web application development using the native Open Source tools provided by Python or Linux server suite development kit (ex. Python Flask or Unix Apache).

- **Standardized IoT development platform** – can become very useful in a situation when the application engineer is not a skilled programmer, or he is interested on the fact of system functionality rather than the level of optimization. A good example in this way is Node RED, Wyliodrin or Thing Speak.

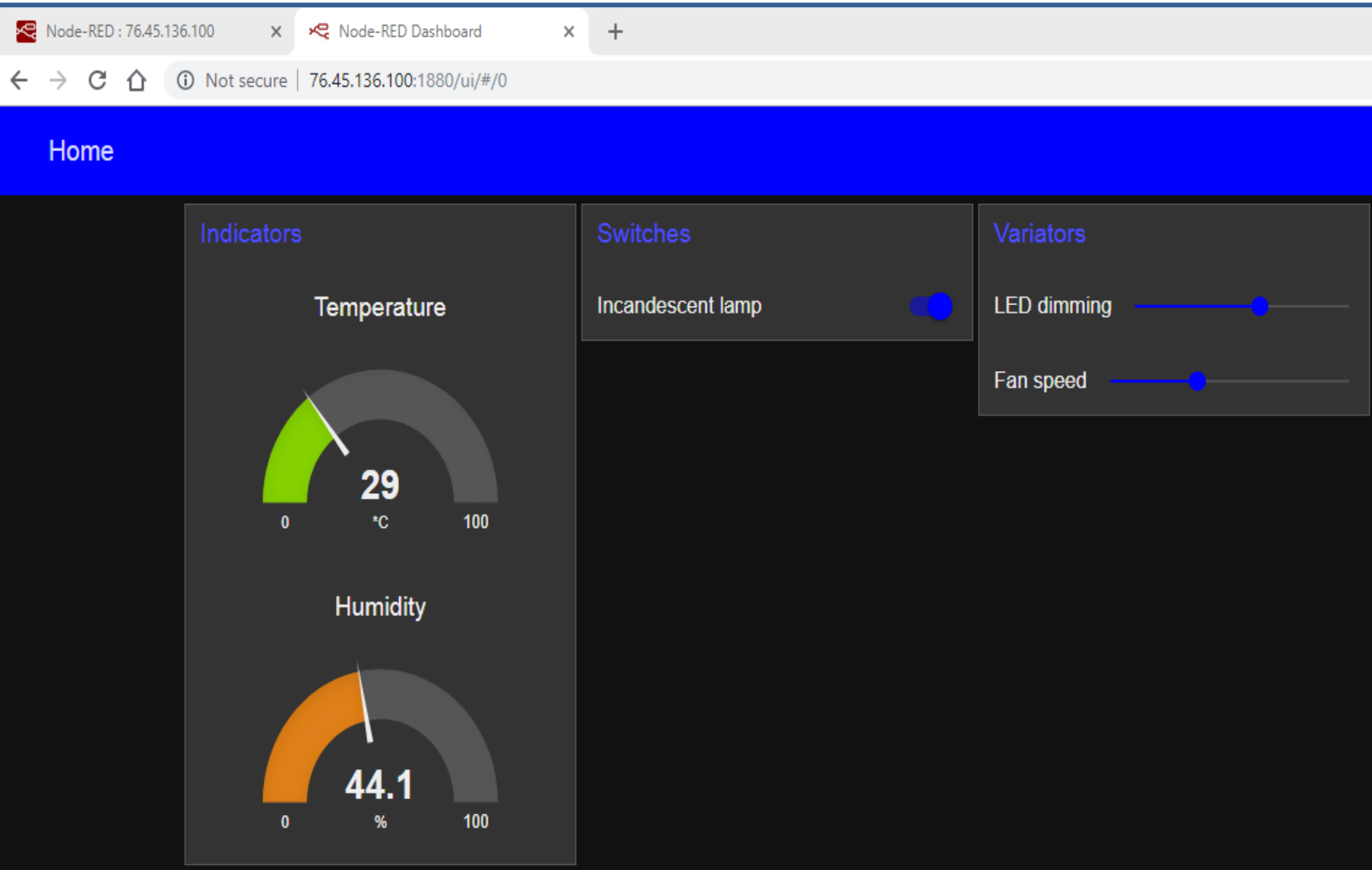
Proof of concept – Singular Python application



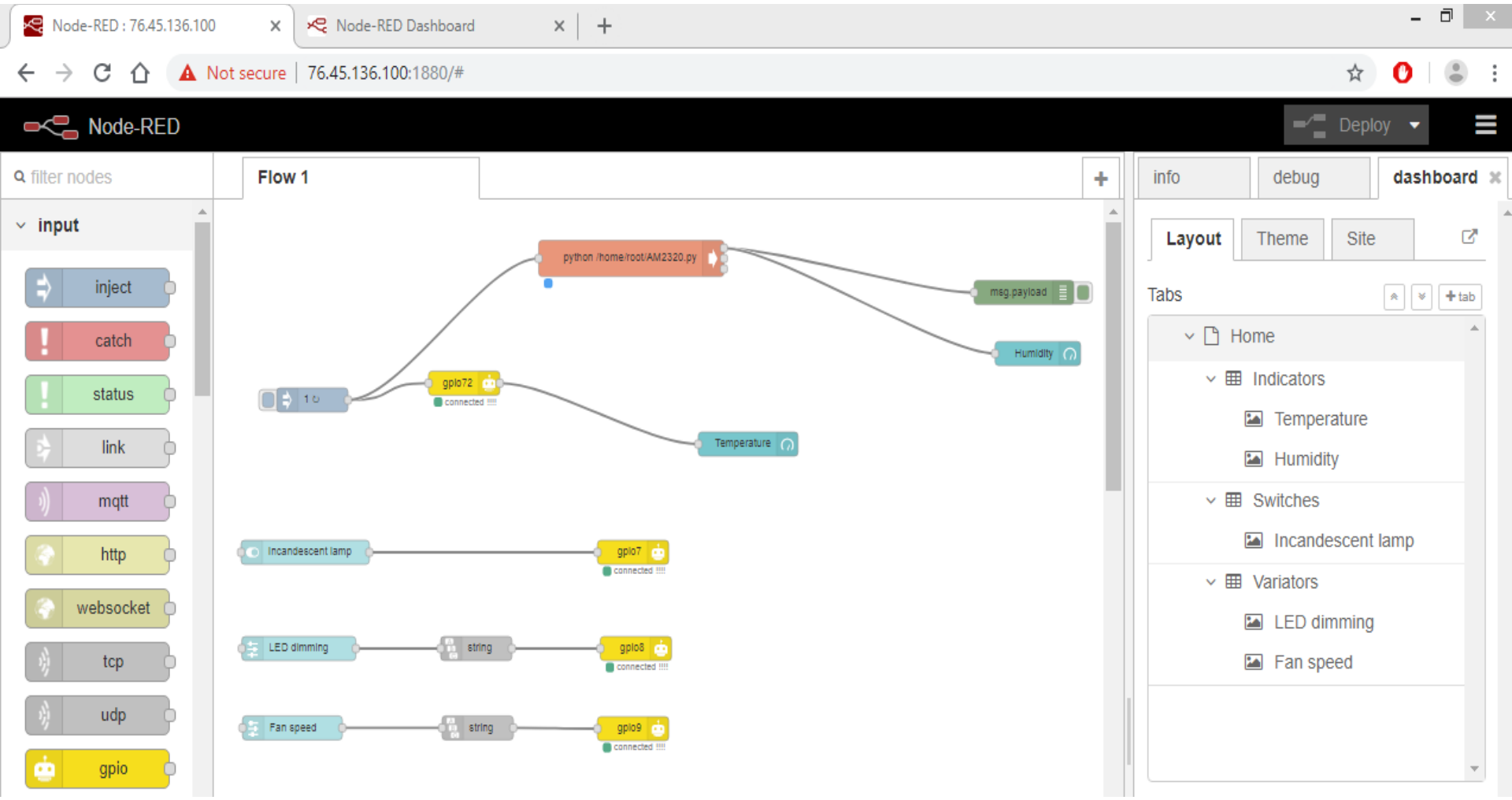
Proof of concept – Webserver Python application



Proof of concept – Standardized IoT development platform



Proof of concept – Standardized IoT development platform



Conclusions

- ✓ Home automation, and human interaction with the physical process is now done easier than ever, thanks to the Internet of Things.
- ✓ Hierarchical structure is one of the best choice in designing microcontroller based automation networks.
- ✓ There are lots of Open - Source choices when it comes to software development of the “human – machine interface”, and now, the Web browser became one of the best way to interact with the process remotely.
- ✓ Using the proposed solutions, based on AVR ATTiny custom made modules, I^2C bus, and Intel Galileo, a simple automated grid can be implemented at low costs.

Thank You!

Pintilie Lucian - Nicolae